

Echocardiographic assessment of mitral valve calcification

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The mitral valve was assessed by echocardiography in 20 patients, aged 27 to 67 years, who subsequently underwent mitral valve replacement. After removal, the mitral valve cusps were examined by direct measurement, radiography, and quantitative calcium extraction.

Increased thickness of the E-F echo was found where calcification or fibrosis was present, differentiation by echocardiography alone being unreliable. However, multiple dense parallel E-F echoes were found in all 10 patients with more than 80 milligrammes of calcium in the valve, while a single thin E-F echo indicated the absence of significant calcification or fibrosis.

This study was undertaken primarily to test the clinical impression that dense E-F echoes denote calcification of the mitral leaflets. The basis of the study was the comparison of preoperative echocardiographic measurements with the operative findings and with the pathological findings in the removed valves, but correlation with the fluoroscopic appearances was also sought.

Subjects and methods

Studies were made on 11 male and 9 female patients aged 27 to 67 years (mean 51 years). Calibrated mitral echograms were recorded, by polaroid photography of the Ekoline 20 ultrasonoscope, shortly before operation (mitral valve replacement) in each case. The technique was that described by Feigenbaum (1972), a C-10 transducer being used. The width of the E-F echo ('E-F thickness') was measured, in the plane of the ultrasonic beam, at three points in each echogram, viz. at the E-point, at the F-point, and at a point midway between the two (Fig. 1).

The degree of any mitral valve calcification seen at preoperative fluoroscopy was graded as slight (1), moderate (2), or heavy (3). Calcification and fibrosis of the mitral valve were subjectively assessed at the time of operation as mild (1), moderate (2), or extensive (3).

After removal, the mitral valve apparatus was x-rayed (Fig. 2) at a tube-film distance of 100 cm and any calcification seen was graded 1 to 3. The thickness of each leaflet was measured with a micrometer at the

middle of its free edge. The degree of any fibrosis present was scored 1 to 3.

The valve was then placed in calcium-free fixative and suspended in a known volume of Custer's decalcifying fluid for 72 to 96 hours. The amount of calcium extracted was estimated by fluorimetry.

Correlation between the *in vivo* and *in vitro* data was sought, using standard statistical methods.

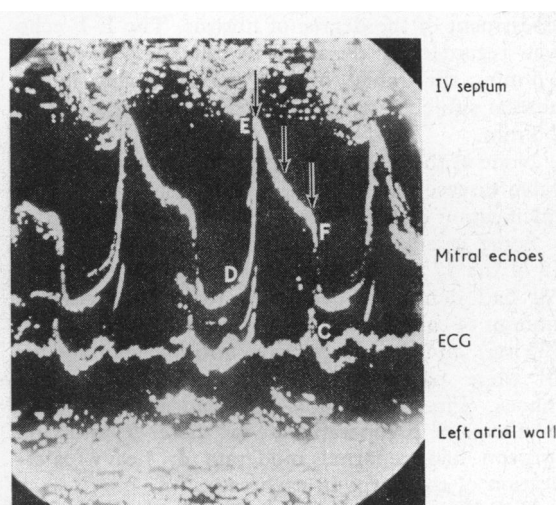


FIG. 1 Mitral echogram showing points (arrows) of measurement of E-F echo thickness and also features of mitral regurgitation from ruptured chordae (D-E amplitude = 45 mm, rapid E-F slope of normal thickness with discordant mitral echoes in systole).

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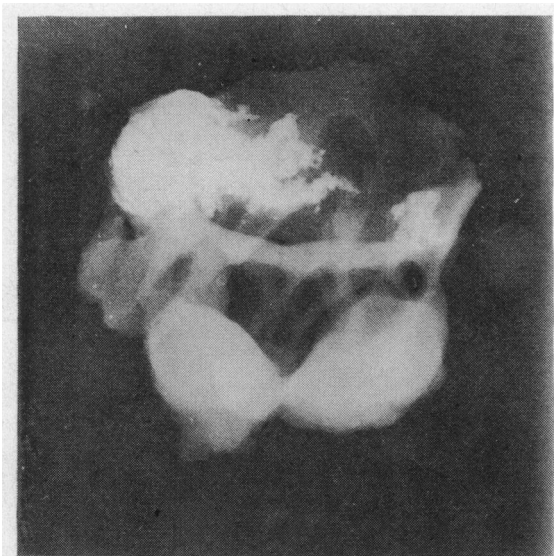


FIG. 2 X-ray film of mitral valve apparatus showing heavy and slight calcification in the anterior and posterior leaflets respectively.

Results

Table 1 shows the fluoroscopic and operative findings and diagnostic data. Table 2 shows the echocardiographic data and *in vitro* details of the mitral valve pathology. There was close correspondence between the surgeon's and pathologist's assessment of the degree of fibrosis. The E-F echo was regarded as dense if its thickness exceeded 2.5 mm, the range of this measurement in 30 normal subjects (aged 16 to 55 years) being 0.5 to 2.5 mm.

None of the 3 patients with non-rheumatic mitral valve disease had dense E-F echoes and none had calcification of the cusps.

Some calcium was extracted from the valve in 15 of the 17 patients with rheumatic heart disease. All had dense E-F echoes. In 9 instances the amount of calcium extracted was substantial (145 to 625 mg), and the preoperative mitral echograms for all these patients showed multiple dense E-F echoes (Fig. 3); fluoroscopy had also detected calcification preoperatively in these 9 and the surgeon had reported moderate or heavy calcification of the cusps in each case.

In 5 of the remaining 6 patients with dense E-F echoes in their echocardiograms (Fig. 4), there was less than 20 mg calcium in the valves, which were moderately or densely fibrosed. In none of these was calcification reported at preoperative fluoroscopy or by the surgeon. One 62-year-old patient

(Case 17), with multiple dense E-F echoes, had 83 mg calcium in her valve; fluoroscopy, but not the surgeon, had failed to detect it.

Neither of the 2 patients (Cases 1 and 3) with rheumatic heart disease but E-F echoes less than 2.5 mm thick had calcified valves.

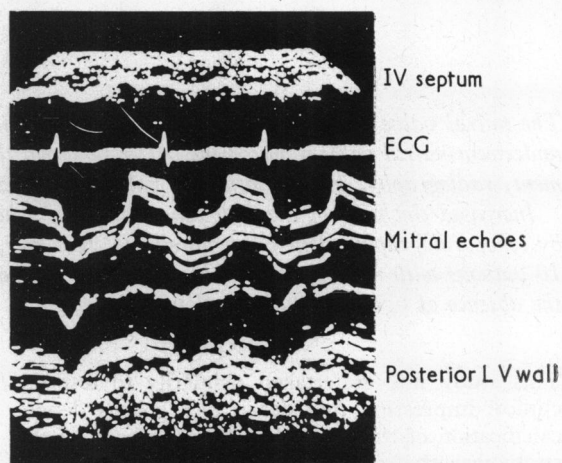


FIG. 3 Mitral echogram showing multiple dense (3 mm) E-F echoes with reduced amplitude of motion ($D-E=12$ mm).

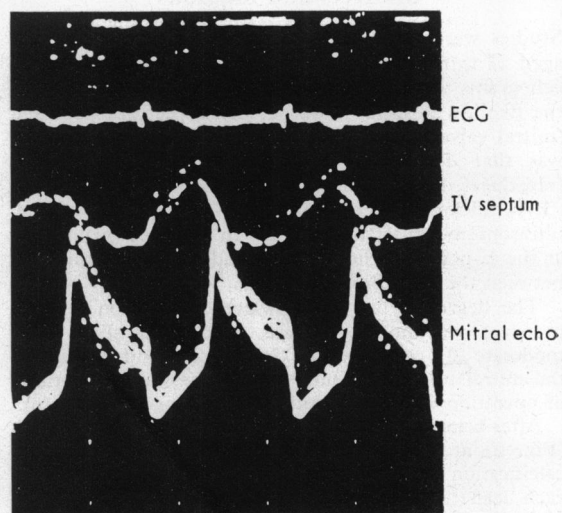


FIG. 4 Mitral echogram showing dense (3 mm) E-F echo with $D-E$ amplitude of 25 mm.

TABLE 1 *Fluoroscopic and surgical assessment of mitral valve*

Case No.	Age (yr)	Sex (M/F)	Diagnosis	Screening for	Operative findings	
				mitral calcification	Calcification	Fibrosis
1	44	M	Rheumatic MS, MR	Nil	Nil	3
2	56	M	Rheumatic MS, MR	1	3	1
3	48	M	Rheumatic MR, MS	Nil	Nil	2
4	48	M	Rheumatic MS, MR	1	2	1
5	41	M	Rheumatic MS, MR	3	3	1
6	60	M	Rheumatic MS, MR	1	2	2
7	55	M	Rheumatic MS, MR	2	3	1
8	42	M	Rheumatic MS, MR	1	2	1
9	48	F	Rheumatic MR, MS	Nil	Nil	3
10	62	F	Rheumatic MR, MS	1	2	1
11	57	F	Rheumatic MS, MR	1	3	1
12	63	F	Rheumatic MR, MS	Nil	Nil	3
13	55	F	Rheumatic MS, MR	2	2	2
14	33	F	Rheumatic MS, MR	Nil	Nil	2
15	48	F	Rheumatic MR, MS	Nil	Nil	2
16	45	F	Rheumatic MR, MS	Nil	Nil	2
17	62	F	Rheumatic MR, MS	Nil	1	2
18	67	M	Non-rheumatic MR, IHD	Nil	Nil	Nil
19	61	M	Non-rheumatic MR (myxomatous degeneration)	Nil	Nil	1
20	27	M	Marfan's syndrome AR, MR	Nil	Nil	1

MS=mitral stenosis. MR=mitral regurgitation. AR=aortic regurgitation. IHD=ischæmic heart disease. 1=slight. 2=moderate. 3=heavy.

TABLE 2 *Mitral echographic and pathological data*

	Mitral echographic features			Mitral valve pathology				
Case No.	Description of E-F echo	D-E amplitude (mm)	E-F thickness* (mm)	Cusp thickness (mm)		X-ray Ca†	Extraction of Ca (mg)	Fibrosis
				Ant.	Post.			
1	Multiple	25	2.0	2.6	3.9	Nil	Nil	3
2	Multiple	20	3.0	3.0	4.0	3	445	1
3	Single	45	2.0	2.0	3.0	Nil	Nil	2
4	Multiple	25	4.0	3.7	3.0	3	240	1
5	Multiple	20	4.0	11.0	3.0	3	625	1
6	Multiple	18	3.0	5.0	5.0	3	190	2
7	Multiple	12	3.0	10.0	8.0	3	430	1
8	Multiple	18	3.0	2.6	1.8	3	260	1
9	Multiple	18	4.0	3.5	4.8	1	7	3
10	Multiple	16	3.0	8.0	8.0	2	145	2
11	Multiple	22	3.0	6.0	2.2	3	265	1
12	Multiple	16	2.7	6.0	3.0	1	5	3
13	Multiple	20	3.0	4.0	6.0	2	170	1
14	Single	18	3.0	3.0	4.0	1	2.5	2
15	Single	22	3.0	4.0	3.0	1	18	2
16	Single	18	2.6	3.0	4.2	1	14	2
17	Multiple	15	3.0	4.0	2.8	2	83	2
18	Single	23	1.5	1.4	1.7	Nil	Nil	1
19	Single	35	1.5	1.5	1.3	Nil	Nil	Nil
20	Single	45	1.5	3.0	4.0	Nil	Nil	1

*No significant difference was found between the three points measured.. †Degree of calcification seen in film of removed mitral valve. 1=slight; 2=moderate; 3=dense.

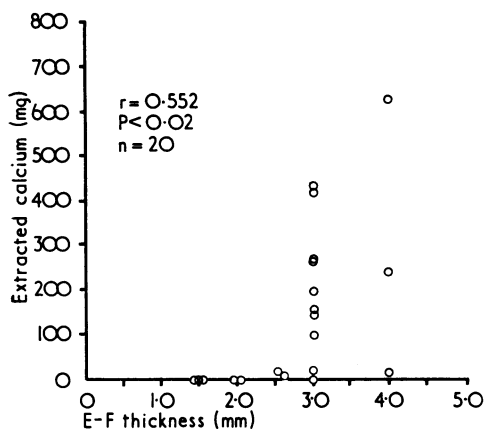


FIG. 5 Correlation of amount of calcium extracted from mitral valve with echocardiographic E-F thickness.

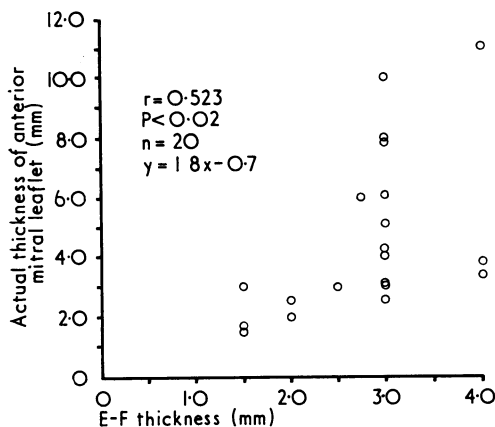
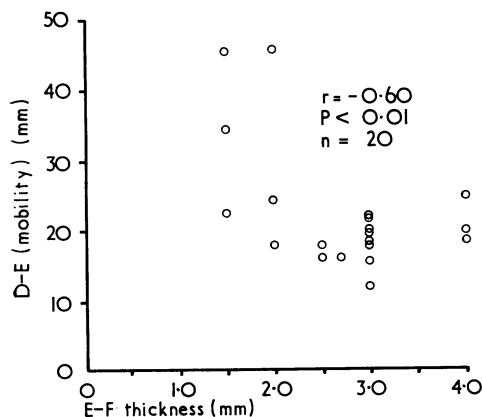


FIG. 6 Correlation of echocardiographic E-F thickness with actual thickness of anterior mitral leaflet.



In the group of 20 patients as a whole, the measured thickness of the E-F echo correlated significantly at the 5 per cent level with (a) the degree of mitral calcification as assessed fluoroscopically ($r=0.48$), (b) the amount of calcium extracted from the valve ($r=0.55$, $P<0.02$) (see Fig. 5), and (c) the actual thickness of the anterior mitral leaflet ($r=0.52$, $P<0.02$) (see Fig. 6).

Significant negative correlation was found between E-F thickness and D-E amplitude ($r=-0.60$, $P<0.01$) (see Fig. 7).

Discussion

Thickening of the E-F echo of the echocardiogram is found where the mitral valve is calcified or distinctly fibrosed. Both processes reduce valve mobility. The findings in this study amplify those of Joyner *et al.* (1965). Substantial amounts of calcium in the valves were always associated with multiple roughly parallel E-F echoes in this series, though the presence of such echoes did not guarantee the existence of important calcification. Heavy calcification and dense fibrosis of the valve appear not to coexist. The thickness of the E-F echo is only an approximate guide to the true thickness of the anterior mitral leaflet, large underestimates being not infrequent. This finding should occasion no surprise in view of the difficulties of standardizing the ultrasound technique and the uneven distribution of the pathological changes in the valve.

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FIG. 7 Correlation of echocardiographic E-F thickness with D-E amplitude.